MARINE PLANTS IN BRITISH COLUMBIA:

MANAGEMENT AND DEVELOPMENT STRATEGIES AND CONSTRAINTS

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L. Michael Coon

June, 1983

Paper No. 2

British Columbia Marine Resources Branch

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MANAGEMENT AND DEVELOPMENT STRATEGIES AND CONSTRAINTS

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A. Introduction

Marine plant populations in British Columbia have long been recognized as a vast but essentially unutilized resource which could contribute significantly to the economy of coastal communities given appropriate conditions of demand and operational economics. The Provincial government's wish to see this potential realized has lead to the investment of several million dollars over the past decade for research and a bureaucratic infrastructure responsible for management, policy development and the provision of liaison and extension services. While many of the principles discussed in this paper apply to all marine plant species, special reference is made to kelp resources. Herein I review the kelp resource management and industrial development strategies which result from the government's investment and then I outline the legal, social and economic constraints which retard the development of the kelp resource in British Columbia. Finally, I will make a projection as to the potential magnitude of kelp industrial developments.

B. Marine Plant Resource Management Strategy

The initial step in this strategy is to develop a basic understanding of the biology and ecological interactions of each resource species prior to its being harvested at any significant scale. A preliminary plan or model can then be produced as a basis for managing pioneering commercial developments. Periodic inventories and monitoring of harvested populations are then needed to update standing crop predictions, to ensure that

harvesting is carried out as stipulated in the licence, and to identify unexpected changes in these populations. Weaknesses in the models will inevitably become apparent and new research should be carried out to improve predictive accuracy, particularly as the maximum sustainable yield level of harvest is approached.

We were fortunate to complete a series of preliminary research projects on the canopy-forming kelps, Macrocystis integrifolia (lesser giant kelp) and Nereocystis luetkeana (bull kelp), prior to the current recession which has sapped government's will and ability to fund proactive research on resource developments. In the following section the results of these studies are used to illustrate the type of information generated and how each is used both in management and industrial planning. Most of this work has, however, yet to be published.

1. Stock Assessment

Knowledge of the location and standing crop of resource populations is essential for resource management planning and development. For example, such data permit government to produce an overall allocation plan based on existing and potential resource users and to set area specific harvest quotas. Industry would use such information to decide whether processing facilities should be land-based near a localized stock concentration or water-based and mobile in order to access stocks available over a wider area. Determination of capacity requirements for harvesting and processing equipment would also be influenced by resource inventory data.

A strong feature of British Columbia kelp inventories has

been the application of a standard method which provides the basis for valid comparison of inventory data collected in different areas and in the same area over time. Figure 1 illustrates areas in which kelp stocks have been quantitatively inventoried using the kelp inventory method (KIM-1) developed by Foreman (1975) as well as areas that have been qualitatively surveyed for kelp presence/absence and species composition. Over 540,000 tonnes of Macrocystis and Nereocystis have been observed in beds totalling over 11,600 hectares in area along almost 670 kilometers of coastline surveyed using KIM-1 (Table 1).

Table 1. Summary of bed area and total standing crop estimates for Macrocystis integrifolia and Nereocystis luetkeana in areas of British Columbia surveyed using a quantitative inventory technique (KIM-1).

Inventory Area	Length of Inventoried Coastline (km)	Bed Area (ha)	Total Standing Crop (Wet Tonnes)
Port Hardy - Malcolm Island	45	635	19,205
Nootka Sound	57	2,165	95,000
North West Vancouver Island	72	840	48,615
North Vancouver Island	68	885	38,020
Estevan Group	82	1,470	77,620
Dundas Group	61	1,527	74,350
Porcher Group	122	1,741	113,575
North Vancouver Island	162	2,375	77,410
Total	669	11,638	543,795

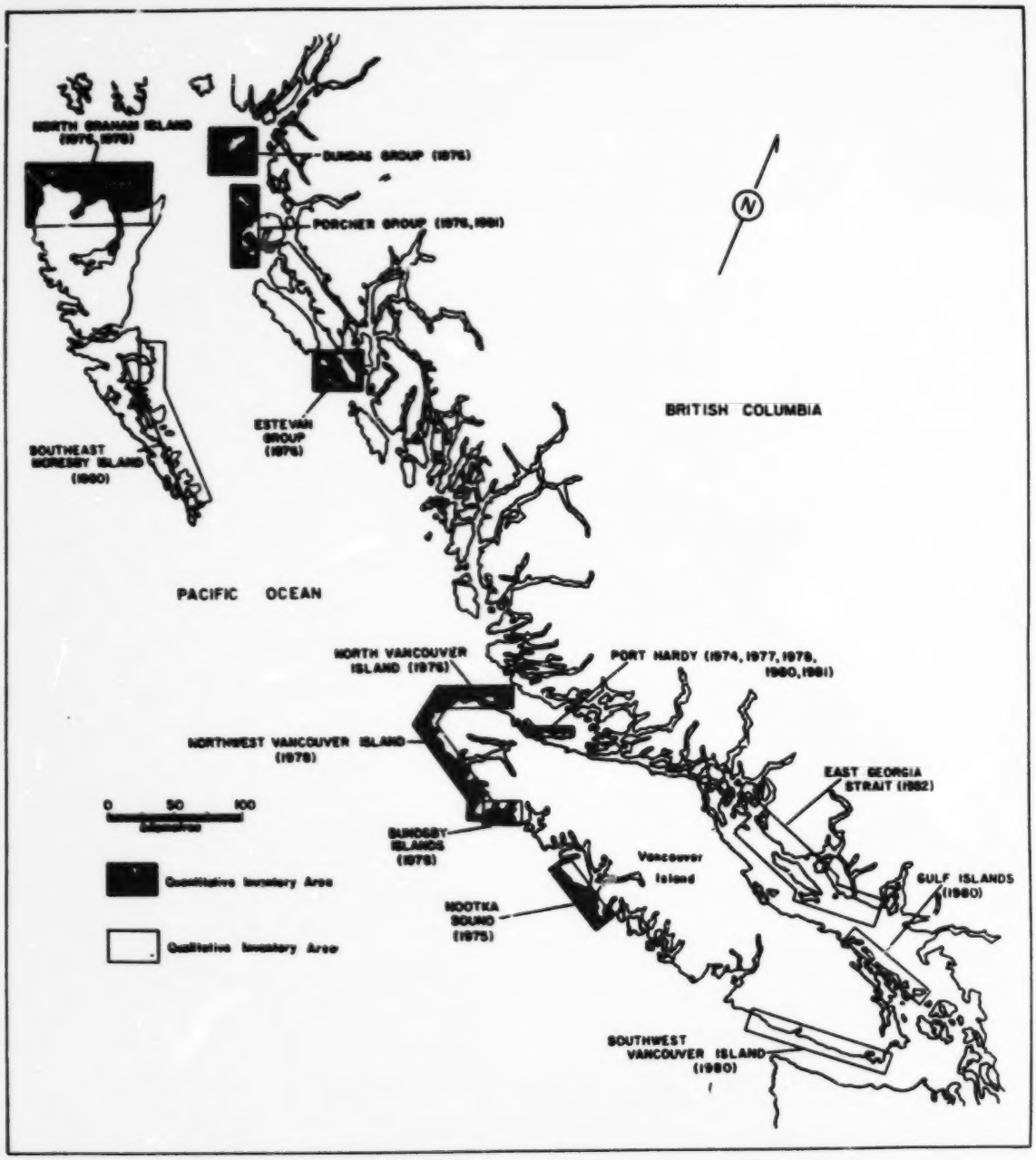

Figure 1. Areas of the British Columbia coastline in which Macrocystis and Nereocystis stocks have either been quantitatively (KIM-1) or qualitatively surveyed. Survey dates are given in brackets following the designation of each area.

If the principles of sustainable yield and multiple species management are to be meaningfully applied inventory data alone provide insufficient basis for scientific management. The information categories which are discussed below either modify inventory information to reflect seasonal or annual changes or otherwise suggest constraints to the full utilization of the resource.

2. Annual and Seasonal Changes

a. Standing Crop

Annual changes in standing crop in unharvested areas indicate the range of response of resource populations to the natural variability of growth-limiting environmental conditions. Changes in harvested areas may then be compared against this baseline as a means of estimating harvest impact. Knowledge of long-term fluctuations are also important in planning resource allocations and industrial development.

Knowledge of seasonal standing crop changes permit a manager to inventory a stock prior to the harvest season and set a quota for a harvest which may be several months in the future. Such data is also valuable in developing an optimal harvest strategy by suggesting a harvest period which would be followed by rapid replacement.

Figure 2 illustrates the annual and seasonal variation which can occur with Macrocystis standing crop. Maximum standing crop occurred in August of both 1980 and 1981, but the 1981 level was reduced by 20%. The May, June and July levels in 1981 were, however, 50% lower than comparative months in 1980. These data illustrate two things:

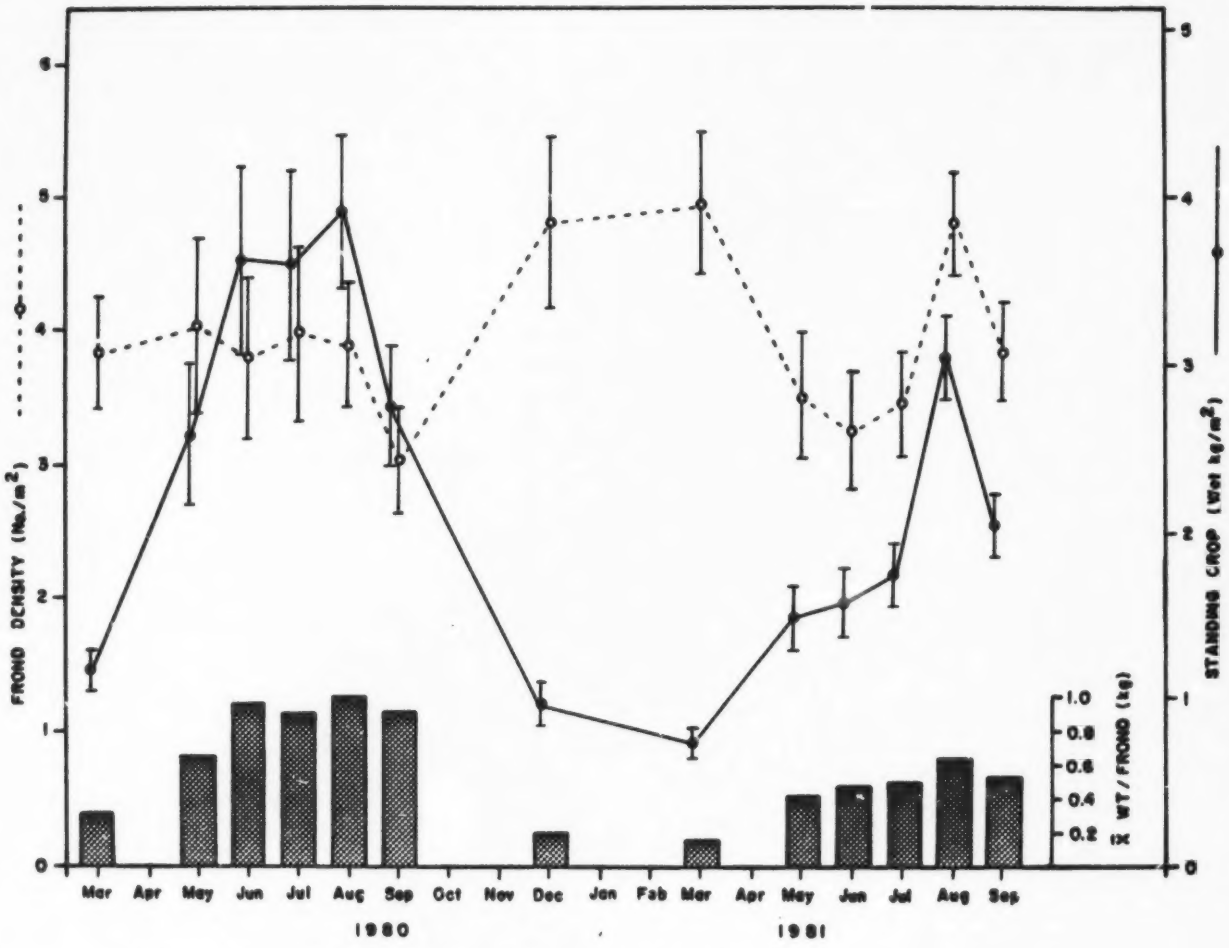
FROND DENSITY (No./m²)
STANDING CROP (Wet kg/m²)
MEAN WT / FROND (kg)
Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep
1980
1981

Figure 2. Changes in Macrocystis standing crop, frond density and mean weight per frond at the Port Hardy study site from March, 1980 to September, 1981. Mean ± standard errors are plotted for frond density and standing crop.

1. that standing crop for any given month can vary significantly between years, and
2. that the rate of biomass change between consecutive months varies markedly between years.

These data suggest that harvestable standing crop predictions based on pre-harvest inventories alone will constrained by large error terms. Correction factors would improve predictive accuracy once the influence of environmental factors on growth were clearly understood.

b. Growth Rate

The standing crop of a marine plant population at any time is the result of interacting processes of which growth is the prime generative factor. Thus studies of seasonal changes in growth rate help explain seasonal changes in standing crop. Ultimately, growth rate reflects the effect of limiting environmental factors acting on the standing crop. Once the relationship between growth and such limiting factors as irradiance, temperature and nitrogen concentration is known, it will be possible to develop a model to predict future standing crop by inputting a current estimate of standing crop and select environment data. Updating the prediction would only require the input of environmental data which is relatively inexpensive to obtain, even using remote sensing instrumentation.

Dr. Ron Foreman and I, working with Nereocystis and Macrocystis respectively, have carried out preliminary work of this type. A good deal of controlled laboratory and field experimentation will, however, be required to produce the types and quantity of data needed for development of the model inferred above.

c. Reproduction and Recruitment

Most of the reasons a resource manager should know the reproductive life histories of utilized species revolve around the potential for harvesting to influence recruitment. Nereocystis, for example, is an annual whose reproductive tissue, being produced on lamina near the sea surface, is subject to removal by harvesting. Adequate allowance can be made for recruitment by using such strategies as delaying harvesting until after the peak of spore production (i.e. until September-October, Foreman, pers. comm.) and leaving uncut strips from which current-borne spores may "seed" harvested areas. Foreman's studies (unpublished) have shown that recruitment in one hectare areas harvested in August-September is as great as in control areas.

In the case of Macrocystis, a perennial, our investigations have indicated that the largest element of recruitment in mature beds results from vegetative splitting of basal holdfasts of mature plants into several distinct individuals. Recruitment by this process tends to be greater in winter months. Macrocystis harvesting is therefore regulated so that mature plants are not destroyed.

d. Biochemical Composition

The commercial value of seaweeds relate to greater or lesser extent to the quantity and quality of particular biochemical components. Both the resource manager and the entrepreneur want some knowledge of the plants:

a. carbohydrate content - particularly phycocolloids such as algin, agar and carrageenan,

b. protein content,
c. fat content,
d. mineral content including salts, trace metals and vitamins,
e. growth stimulating activity to agricultural species, and
f. digestibility and edibility to humans and livestock.

It is equally important to determine how the levels of particular components vary seasonally, geographically and in relation to reproductive condition. This information may suggest an optimal harvest period. Virtually all of the biochemical investigations relating to British Columbia seaweeds have been performed by Dr. Ian Whyte of the Vancouver Laboratory, Department of Fisheries and Oceans. More recently Dr. Lalit Srivastava of Simon Fraser University has studied seasonal changes in algin, fucoidan, mannitol and various elements from Macrocystis and Nereocystis collected from the north and south coasts of British Columbia.

3. Effect of Harvest on Resource Populations

The Marine Resources Branch embraces the concept of "optimum sustained yield" as the basis for management of marine plant resources in British Columbia. Optimal yield considerations must, however, never dictate harvest at greater than the maximum sustainable yield level. Sustaining harvest yield requires that a stock be maintained at or above some defined minimum level. To do this a manager needs to estimate the effects of harvesting on regrowth and/or recruitment. Preferably this information will be available before the resource is exploited. Given the legal ability to establish harvest conditions we can, however,

generate such information in the pioneering stages of industrial development when low harvesting levels minimize the risk to the resource base.

For Macrocystis we were able to carry out a harvest program which measured the effects of cutting height above the seabed, season of harvest and frequency of harvest on regrowth over a three year period (Coon, 1982). We discovered that to achieve a 100% or better annual recovery of standing crop, areas harvested once a year should be cut at 4.5 m above the seabed in May, June or July. Harvesting in the latter portion of this period would be preferred in years when growing conditions are poor. Areas cut later in the summer, while producing a high yield, will usually require more than one year to recover. It also appears that Macrocystis responds well to multiple cuts per year as long as cuts are made at 4.5 m above the seabed and the May-August or May-July-September cutting schedules are applied (Figure 3). In plots cut at 1.5 and 3.0 m above the seabed the 100% regrowth objective was almost never realized.

4. Effect of Competing Flora and Herbivorous Fauna on Resource Populations

Competing flora and herbivorous fauna have the capacity to influence the standing crop of resource populations, sometimes in a catastrophic fashion. Ignoring this threat would be folly for a resource manager.

Foreman (1977) documented the effects of both competing flora and sea urchin herbivory on a Nereocystis population in Georgia Strait. On the basis of his results Foréman describes Nereocystis as an "opportunistic" species which is able to out-

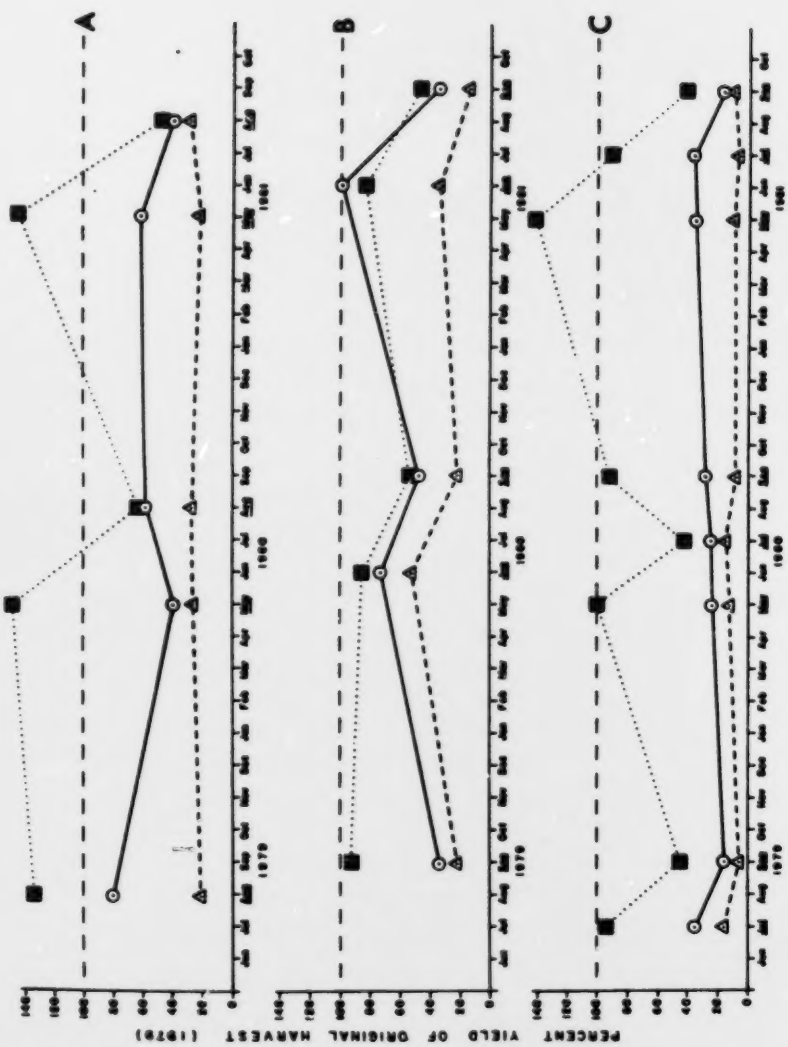

Figure 3. Regrowth of Macrocystis in 1200 m^2 plots harvested two or three times per year, compared to the initial yield in 1979. In (a) cuts were made in May and August of each year, in (b) cuts were made in June and September and in (c) cuts were made in May, July and September.

complete perennial forms for attachment space, light and nutrients only in habitats subject to regular perturbation.

Nereocystis populations which persist for many years are likely to be located in areas which receive regular perturbations, such a heavy winter wave action. Hence, a manager would be wise to concentrate inventory and harvest effort in areas where this species apparently has a natural advantage, as evidenced by its long tenure, over its competitors. Urchin problems are not as easy to avoid since it is currently not possible to predict where and when successful recruitment to urchin populations will occur.

The effects of intensive urchin grazing are spectacular. Between September, 1976 and September, 1981 the Nereocystis stock in a 7 km section off the Porcher Island coastline declined from 36,000 to 195 wet tonnes (Figure 4). Diving investigations revealed that a once prolific kelp forest had been reduced to a barren ground in which urchins were the only prominent organism. This finding was not without consequence since this area had been designated for harvest beginning in the fall of 1981.

Several urchin control measures are available, but most are economically prohibitive. Exclusion of urchins by fencing areas (Pace, 1975), or causing mass mortalities by spreading quick lime or crushing individual urchins (Wilson et al, 1979 for example) probably fall in this category. Economically viable options might include the commercial harvest of urchins or long term urchin control by the reintroduction of a major predator, the sea otter. The latter of these is likely the only attractive alternative since urchins in barrens may not be as dense (Bernard & Miller, 1973) and may not have as high a gonad index as commercially attractive populations.

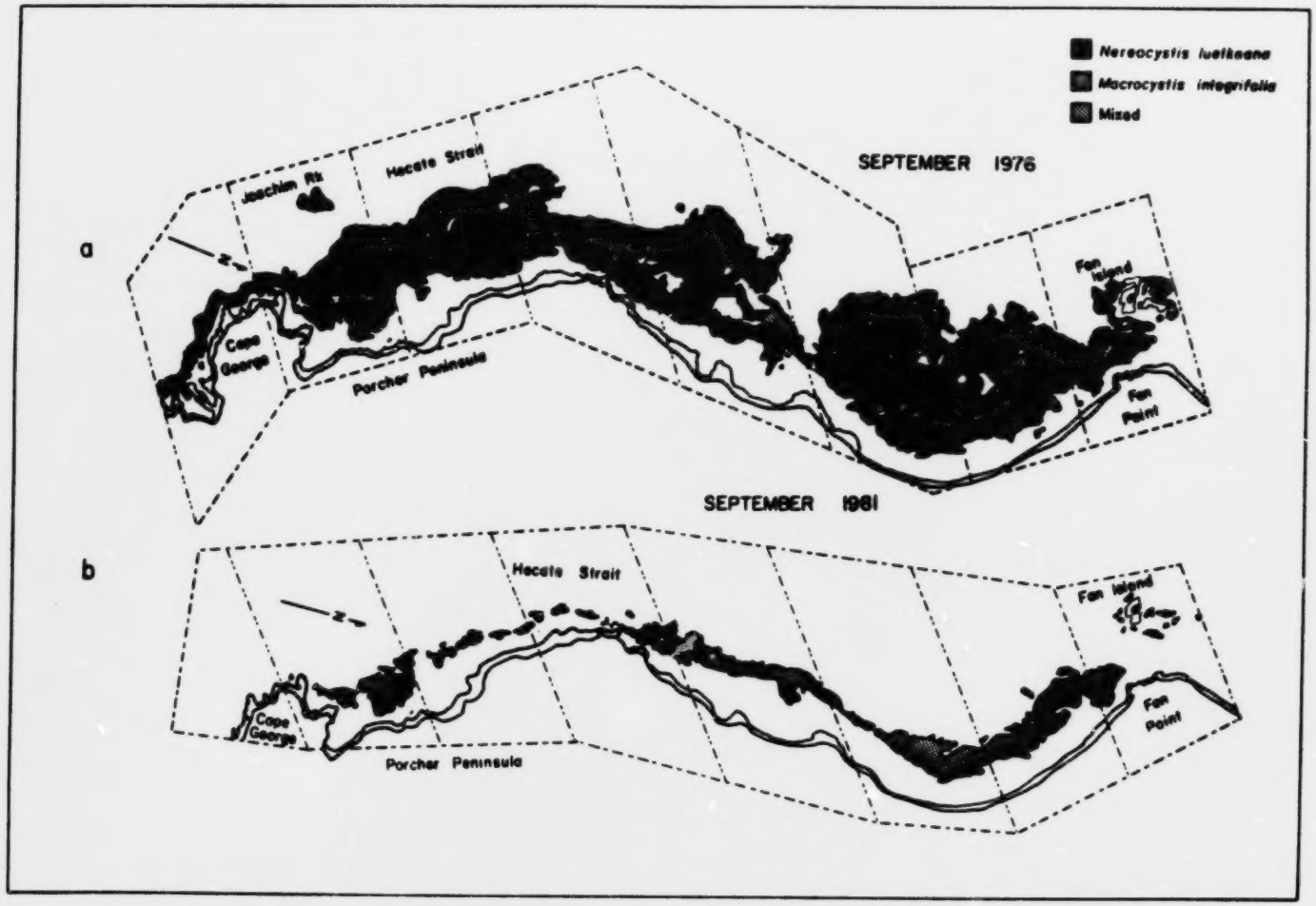

Figure 4. Changes in the bed area of Nereocystis off Porcher Island between September, 1976 and September, 1981. In September, 1981 the area previously occupied by an extensive Nereocystis bed was an urchin dominated barren ground. Dashed lines drawn more or less perpendicular to shore are 1 km apart.

5. Effect of Marine Plant Harvest on Associated Fishery Resources

Increasing pressures on many natural resources have made it abundantly clear that individual species can not be managed in isolation if we are to avoid undesirable impacts on associated resources. We are entering an era of multiple species management in part because we are beginning to recognize and appreciate the essental links between plants, animals and their abiotic environment. In British Columbia there is a greal deal of conventional wisdom, but, unfortunately, very limited scientific knowledge, linking fish production to kelp beds. We, therefore, embarked on a program to study fishes in kelp and other nearshore habitats to gain insight into importance of kelp beds to commercially valuable fish (Black, 1981).

Fish occurrence, abundance and persistence in the kelp habitat were selected as measures of importance of this habitat to fish. Our first objective was to determine whether or not nine commercially valuable target species occur with greater frequency in commercial kelp beds than in other nearshore habitats. Secondly we wanted to elucidate the trophic inter-relationships between the target species and their prey in kelp and other nearshore habitats. The third objective was to document the spatial and temporal occurrence of fish and plankton in commercial kelp habitats. The information produced from these studies will be used to predict how occurrence and distribution of fish might be influenced by kelp harvesting and to suggest methods of mitigating possible negative efforts of kelp harvesting. This is one element in the determination of optimal sustainable yield for kelp.

Although the final report will not be available for about six months, portions of the report, including results concerning the temporal and spatial occurrence of the target species and their catch frequency by size class, time period and habitat have been made available to Federal fisheries and habitat managers and research scientists for review and comment. On the basis of the available analyses we conclude that kelp harvesting would not result in deterioration of habitat that is essential or critical to the species studied.

B. Industrial Development Strategy

Our goal is to derive maximum economic and social benefit from the marine plant resources of British Columbia. We progress towards this goal along two parallel paths - the first concerned with utilization of wild stocks and the second with development of marine plant mariculture. Mariculture, however, will not be dealt with in this presentation. In developing management capability for wild stocks our objectives are to determine optimal sustainable yield for each major stock by the methods previously described and to facilitate industrial utilization up to this level. In this portion of my presentation I will outline the legal and policy framework within which the industry must develop and the strategies we have evolved to facilitate the development of the kelp industry.

1. Jurisdictional Mandate and Regulatory Powers

Legislative authority to manage marine plant resources and regulate the harvesting and processing sectors of the industry are conferred on the Marine Resources Branch by Section 24 of the Fisheries Act (British Columbia). Details of regulatory

control are given in Part II of B.C. Regulation 140/76. These regulations provide for:

a. licence fees and reporting requirements for both harvesting and processing sectors,
b. payment of royalties on harvested marine plants,
c. harvest licencing on the basis of species groups,
d. definition of the harvest area,
e. setting a harvest quota for the species group in the harvest area,
f. designation of approved harvest equipment,
g. designation of the manner in which harvesting may be carried out, and
h. closing areas when necessary for conservation purposes.

Marine plants are a "common property" resource owned and managed by the Province on behalf of the citizens of British Columbia. The Fisheries Act stipulates that persons apply for and be issued licences before commercially harvesting or processing marine plants. The issuance of a licence is not, however, automatic. The Minister has the authority to decide against issuing a licence. The conditions under which the Minister can apply this authority are given in Subsection 24(9) which states in part:

> "...the minister...may...refuse to issue a licence under this section if at any time in his opinion the harvesting of kelp or other aquatic plants under the licence would
> a. tend to impair or destroy any bed or part of a bed on which kelp or other aquatic plants grow;

b. tend to impair or destroy the supply of any food for fish; or

c. be detrimental to fish life."

2. Licensing Policies

a. Licence Limitation

It is our policy to match the scale of resource utilization to our management capability. This is the only way that we can be confident that harvesting marine plants will not cause significant negative impacts to associated marine life. Licence limitation, which has its legislative basis in Section 24(9), is our prime means of affecting this policy. A consequence of this policy is that industrial participation and the scale of operations are limited from the outset. In our view, this is preferable to having limitations imposed on established users.

Licence limitation also provides a means for government to prevent over-capitalization in the primary and secondary sectors of the industry. The value of such controls has been made very clear in the Pearse Report (Pearse, 1982) on the fishing industry in British Columbia. The theoretical size, cost and raw material requirements of profitable individual units in the kelp meal and algin extraction industries (Woods Gordon, 1980 and Moss, 1977) also dictate that participation be limited.

b. Licence Allocation

There is an element of flexibility in our application of the control measures provided in legislation which reflects our resource management capability, the scale of proposed industrial utilization and the threat such utilization poses to the

resource base and associated marine life. Licences have and continue to be issued on a "first come - first served" basis to persons wishing to pioneer the commercial harvesting and processing of particular species as long as certain conditions are met:

1. the proponent must present evidence that the overall operation is economically feasible; and
2. the raw material requirement is low, either in absolute terms or compared to the estimated standing crop in the desire area, or both.

Licencing is preceded by stock assessment regardless of the harvest quota requested. However, not in all cases does a body of other management information exist. Where little information exists on the desired species we may issue a harvest licence with a view to gathering management-related data concurrently with the commercial operation.

If an operation is successful at this small scale, and assuming that management studies over several years indicate that industry expansion is possible, the Branch will entertain requests for increased quotas and larger harvest areas. However, opportunity for industry participation will be made available to other interested persons at that time.

Interested persons are invited by the Branch to submit development proposals. The Branch offers an annual harvest quota for a given number of years and may specify a harvest area. Proposals received are adjudicated by a panel of resource managers and economists on the basis of economic and technical criteria. The person submitting the strongest proposal (i.e., that most likely to result in an economically viable and

environmentally sound operation) is granted the appropriate harvesting and processing licences, or guarantees of these once certain pre-operational performance criteria are met.

This same procedure is followed in the event of marine plant resource developments which have a relatively large initial raw material requirement whether or not they are pioneering. In this case of kelp developments we already have a biological basis for management so the offer of a larger annual harvest quota is justified.

There is an exception to this allocation policy. The Federal Department of Fisheries and Oceans issues 28 licences per year for the herring spawn-on-kelp industry. Provincial licences are issued without competition to each Federally licenced operator that applies in order to regulate the harvest of kelp.

c. Exclusive Privilege

There are several reasons why marine plant harvesting licences generally confer exclusive harvesting privileges within a defined area. One reason is basically biological in nature. Harvestable seaweeds are attached to the seabed. Populations are relatively static in space though there are often marked seasonal and annual changes in standing crop. Because of this, seaweeds are not "hunted" as are fish, but can be "cropped" in a manner analogous to hay or forest resources.

Granting exclusive privilege in a defined area reduces the effort and manpower needed to manage the resource. This is particularly important at this early stage in the development of the industry when government, while promoting industrial development, is not willing to allocate the resources nor has it acquired the skills to manage the resource at the maximum sustainable yield level.

Exclusivity is not only a privilege for the licencee, but it makes that person solely responsible to ensure that the terms of the licence are met. Exclusive harvesting privileges should promote a sense of resource stewardship, since the licencee will suffer the results of any abuses to the resource.

Finally, it is difficult to separate exclusivity from area-specific licensing, particularly when the licence not only stipulates a harvest quota, but may stipulate a harvest plan. If two licences can be accommodated within a given area, we feel that the area should be clearly divided between the two. This policy is implemented by the simple expedient of issuing only one licence per species group for a given area.

Only with herring spawn-on-kelp industry have we found reason to modify this policy. The many uncertainties of these operations often result in relocation several times each season. Areas defined in these licences are therefore typically quite large relative to the quota, and may be shared by several operators. In the future it may be necessary to separate the areas allocated to spawn-on-kelp operators from other kelp users.

d. Tenure

Subsection 6.1 of the Regulations stipulates that licences are renewable annually. However, as a matter of policy we have considered that, given beneficial use, a licencee will have the "first option" to harvest the same quota (unless conservation needs demand a decrease) in the same designated area each year.

The major reason for having any form of guarantee of supply is to encourage industrial development. Few, if any,

entrepreneurs are likely to risk capital without some form of guarantee of adequate raw material supply. This is particularly true at the outset of new industrial enterprises, before profitability has been determined by experience.

Long term economic considerations make it advisable to place limits on tenure, even of the "first option" type. This will become particularly important once the resource base has been allocated at or near the optimal sustainable yield level. We are considering the following:

1. fixed-termed tenure: granting "first option" tenure for a period not to exceed 20 years;

2. performance clauses: tenures would be maintained only if some quantitative criteria of beneficial use of allocated resources is demonstrated. We have applied performance clauses to kelp harvesting licences in the past.

Ministry of Forests economists suggest that the Crown always hold some portion of a resource in reserve, as well as ensure that some portion of previously allocated resources is being returned to the Crown from the expiry of tenure. This will ensure that the resource management agency has at its disposal a reserve which can be allocated for new or specific uses in response to changing market preferences and/or general economic conditions.

2. Kelp Resource Development Strategies

a. Potential large volume uses - kelp meal and algin extraction

A sequence of events beginning in 1978 resulted in formulation of a strategy for development of the kelp meal and alginate industries. A market study (Woods Gordon, 1978) indicated a positive potential for kelp meal and algin extracts in a growing world market. However, a later study (Woods Gordon, 1980) identified several economic constraints to a viable kelp meal enterprise, including a declining market demand. Shortly thereafter, a supply restriction in the kelp meal market suggested that a viable enterprise could become a reality since the whole remaining market was open. At about this time we adopted the policy of linking the scale of resource developments to our management capability. Having developed some expertise we felt it reasonable to permit a small scale kelp enterprise to begin.

The following progression was formulated as a strategy for the development of the kelp industry:

i. Initiate the industry by providing a single licence and allocating enough raw material (maximum of 5,000 tonnes) to satisfy the market demand for kelp meal.
ii. Manage the harvest operation for a five year period in such a way that the sustainable yield of kelp and the habitat needs of associated fishery species can be determined. These studies would determine the biological limits to larger scale kelp developments.
iii. Modify the kelp management plan, if necessary.
iv. Divide the coast into major resource pools with a north-south dividing line at Cape Caution.

v. Offer a single licence and an annual harvest quota of 20,000-50,000 wet tonnes in one of the resource pools to initiate an algin extraction industry.

vi. Monitor impacts of harvesting on kelp recruitment and fishery resources in the larger harvest area.

vii. Modify the kelp management plan, if necessary.

viii. Offer a second licence, as above, for a second alginate enterprise to operate in the remaining resource pool area.

ix. Monitor kelp stocks and industrial operations coastwide on an ongoing basis to update input to management model and ensure compliance with licence conditions.

This strategy provides for reassessment and refinement of the management plan at each stage of development. Large scale allocations would only be made if warranted by the results of monitoring studies at the kelp meal stage.

In final analysis, development of a large scale kelp industry will be determined by its effects on fishery resources. If, as it has in California (North and Hubbs, 1968), harvesting can be carried out in such a manner that no significant negative effects are noted with associated fishery resources, then the industry will be allowed to develop to its full potential, limited only by market supply and demand constraints and the requirements of sustainable yield management. If significant fishery "costs" can be tied to kelp harvesting, then the respective management agencies will have to weigh these "costs" against the benefits accrued by the kelp industry. If these benefits do not at least balance the losses, then the kelp industry will be restricted until the problem can be reduced to an acceptable level or ameliorated altogether. If this proves not to be possible, then the kelp industry will be curtailed.

b. Low volume uses - spawn-on-kelp, fertilizer products mariculture feeds

The small allocations to these users poses no problem at present, but with the advent of large scale industry means will have to be developed to ensure ongoing access to stocks of sufficient size to meet current demand as well as allow for reasonable future growth. This might best be done by setting aside the area or portions of areas currently favoured by these users. The stocks in these areas would not be considered as part of the resource pool available to large scale users. The economic incentive to ensure a continuing supply of kelp to these small scale users is prominent. The herring spawn-on-kelp industry, for example, produced $3.86 million of product in 1982, using only about 90 wet tonnes of Macrocystis.

C. Constraints to Development of the Kelp Industry

Events of the past two years have served to focus attention on several factors which continue to retard development of the kelp industry.

1. Legal

Legal uncertainties play a prominent role in maintaining the current development hiatus. The cause of this uncertainty is the mutually exclusive claim for the ownership of and regulatory control over the marine plant resources of British Columbia by both Federal and Provincial Governments. Despite many high level discussions between 1970 and 1977 this issue has yet to be officially resolved.

An informal working agreement between the Department of Fisheries and Oceans and the Ministry of Environment provides for Provincial licensing of commercial marine plant harvesting,

on the basis of Provincial legislation, and a de facto moratorium on the application of Federal legislative authority. Federal concerns respecting marine plant harvesting are currently expressed through two avenues:

i. a licence referral mechanism, and
ii. a working group of resource and habitat management and research biologists which focuses on technical consideration of development proposals and acts in an advisory capacity to the Directors of both Federal and Provincial agencies.

Despite these arrangements, entrepreneurs remain leary of investing in kelp developments, even though duly licenced by the Province, when the possibility of Federal intervention threatens. Only with resolution of the jurisdiction issue and clear definition of the lines and extent of the Federal and Provincial authority, can this situation be expected to change.

2. Social

Much of the social concern regarding commercial utilization of the kelp resource revolves around the widespread belief that kelp beds are critical fish habitats and the fear that harvesting will result in reduced fish production. Commerical and recreational fisherman and local service and supply businesses which rely on fishery-based incomes and recreational spending, fear reduced fish catches and the resultant economic hardship or reduced quality of recreational experience. Native Indian people share these concerns but are also worried about the effects kelp harvesting may have on species they traditionally harvest as food.

The Haida Nation, and perhaps other tribes, have made formal claims of ownership of marine resources, including kelp, and want no one else using "their" resource. Many other tribes express the same sentiments without having made formal claims of ownership. Compounding this particular issue is the expressed desire of many coastal bands to benefit directly by taking a leading role in marine resource developments slated for the area of their ancestral tribal influence. Several Native groups have demanded the right of first refusal to participate in kelp developments.

Our current policy dictates that proposals be invited from all interested parties and that those received from Native people be rated against others solely on their economic and technical merit. In the single instance that we requested proposals for development of the kelp meal industry, none were submitted by Native groups.

The resource management and industrial development strategies described earlier should help calm the fears of fishermen respecting commercial utilization of kelp. Resolution of Native claims and demands, and satisfaction of their legitimate desires to participate in resource developments will, however, require action at the most senior levels of political decision-making.

3. Economics

Shifting and especially declining market demand can be expected to be the primary influence on industrial viability. The kelp meal market, for example, was estimated to be 1600 dry tonnes in 1978 and experiencing real annual growth of 10-15% (Woods Gordon, 1978). Yet a market update in 1980 (Woods

Gordon, 1980) revealed that the market had declined to 320 tonnes, although subsequent events suggested that the whole of this market was available to a British Columbia producer.

The production of alginic acid and its derivative salts offer the greatest economic potential to the British Columbia kelp industry. However, alginates must be price-competitive in an international gums market and are subject to substitution by or blending with more cost effective gums. At present alginates tend to be employed only where their particular physico-chemical properties are essential. Although average annual market growth of 6-7% was experienced during the 1970's, Woods Gordon (1978) speculated that real annual world market growth might decline to 2-4% until the early 1980's. We have no hard data on current alginate markets but expect that the recession has reduced alginate sales and annual market growth.

Existing major sources of kelps for alginate production are reported to be utilized at or near the maximum sustainable yield level (Woods Gordon, 1978; Moss, 1977). We expect, therefore, that British Columbia could become a new source of alginates to meet the demands of a growing world market. Competition from the following sources is our major concern:

1. other major untapped natural kelp resource areas such as Argentina and Chile (Michanek, 1975);
2. the massive oceanic Macrocystis farms currently being proposed as a source of biomass for methane production (North et al, 1982) but which could be used for alginates;
3. the Peoples Repulbic of China which could divert significant quantities of the alginate it extracts from cultured Laminaria from internal use to the world market (Tseng, pers. comm.).

Probably the most frustrating of all problems being faced by the emerging kelp industry is the securing of risk capital. Major financial institutions such as chartered banks have a history of being unwilling to lend money to new businesses where the risk factor is considerable. Contributing to this attitude is a lack of proven local industrial expertise and, even more importantly, the lack of proven profitability of kelp enterprises. As well, past, ill-fated kelp developments have not served to generate confidence amongst private sector investors. Typically, government financial assistance programs require long lead times before decisions are reached. Differing priorities and political postures between the Federal and Provincial partners in joint funding programs could well retard kelp proposals relying on such funding.

D. Kelp Industry Potential in British Columbia

1. Herring Spawn-on-Kelp

The constraints noted above have little if any affect on the herring spawn-on-kelp industry. This solidly established fishery-mariculture industry enjoys the support of both Federal and Provincial governments. The number of licences and legal product output could be doubled to meet market demand if Federal licence allocation problems were resolved. If this were done, the wholesale value of spawn-on-kelp should increased to about $7.7 million/year.

2. Kelp Meal

According to our latest market information the kelp meal industry could immediately begin production of about 300 dry tonnes with a wholesale value of about $560,000/year. It is

likely, however, that a smaller tonnage would be produced in the initial years of operation. Past market trends suggest that with stable supply and reasonable price the market could regain at least part of its former North American level.

3. Alginates

In 1978 the annual world market for alginates was estimated to be 21,900 tonnes. Using the most conservative estimate of real annual market growth (2%), the demand increases about 440 tonnes/year. About 2% of the wet weight of kelp is alginate. If we were to allocate an annual harvest quota of 20% of the August-September kelp standing crop for alginate production, British Columbia could, at best, supply 2160 tonnes of alginate to the world market. This represents only five years market growth. The wholesale value of this material (based on 1978 prices and dollar value) would range between $9.5 and $13.1 million/year, depending on the algin salt produced.

E. Conclusion

On the basis of the above product potentials it is easy to predict that the kelp industry could have a bright future. Certainly this potential warrants the earnest efforts of all concerned to resolve the constraints identified earlier. In some instances the constraints may be unresolvable by local interests in the short term. In this event industrial proponents must either proceed with development recognizing these as ongoing limitations in a less than perfect world, or opt out altogether.

The Marine Resources Branch sees little point in continued expenditure on basic kelp research and further refinement of its

management capacity unless its efforts are matched by industrial development. Will industry respond to the opportunities in light of the constraints it still faces? The simple answer is "It is trying." I hope it succeeds. I hope that the kelp industry will establish itself as a full partner in that broad matrix of renewable marine resource industries which form the lifeblood of many of our coastal communities.

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